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Are fluctuations in energy consumption transitory or permanent? Evidence from a Fourier LM unit root test

Veli Yilanci [a,*], Çiğdem Börke Tunali [b]

[a] Sakarya University, Faculty of Economics and Administrative Sciences, Department of Financial Econometrics, Esentepe Kampusu, Sakarya, Turkey
[b] Istanbul University, Faculty of Economics, Department Economics, Beyazit, Istanbul, Turkey

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ABSTRACT

In this study, we employ a recently introduced unit root test with a Fourier function that is capable of capturing the unknown nature of structural breaks, to reexamine the stationarity properties of energy consumption per capita of 109 countries over the period 1960–2011. The results of the Fourier Lagrange Multiplier unit root test show that the energy consumption per capita for Algeria, Australia, Benin, Bolivia, Canada, Costa Rica, Denmark, Egypt, Greece, Guatemala, Hong Kong, Ireland, Jordan, Korea Democratic Republic, Mexico, Myanmar, The Netherlands, New Zealand, Oman, Paraguay, Qatar, Singapore, Tanzania, The United States and Vietnam is stationary, indicating that energy demand management policies will not be effective on energy consumption in the long term. In addition to this, since the energy consumption in these countries does not contain a unit root, future movements in energy consumption can be predicted by employing historical behaviors.

Contents

1. Introduction

Stationarity of energy consumption has become a hotly debated issue in recent years. There are several reasons why this issue has come into prominence both for economists and policy makers. The first reason is the question of whether energy consumption that has a unit root has significant implications about the effects of shocks on energy markets? If energy consumption is stationary, policies about the management of energy demand will have only temporary effects on energy consumption. On the other hand, if energy consumption has a unit root, energy demand management policies will affect energy consumption permanently [1]. This is compatible with path dependency or hysteresis in energy consumption [2]. Path dependency or hysteresis in energy consumption means that shocks in energy markets will have persistent effects on energy consumption. However, if energy consumption is stationary, shocks in energy markets will affect energy consumption transitorily [3].

The second reason: unit root properties of energy consumption are of great importance and connected with the relationship between energy consumption and other macroeconomic variables. Energy consumption has a crucial correlation with the economic system and can influence the productivity of capital and labor [4]. Hendry and Juselius [5] state that "*variables related to the level of any variable with a stochastic trend will 'inherit' that non-stationarity, and transmit it to other variables in turn*…" So, given the relationship between energy consumption and the economic system, if energy consumption contains a unit root, then the other macroeconomic variables such as output and employment can inherit that nonstationarity as well [6].

* Corresponding author. Tel.: +90 264 295 62 31; fax: +90 264 295 62 33.
E-mail addresses: yilanci@sakarya.edu.tr (V. Yilanci), cbtunali@sakarya.edu.tr (Ç.B. Tunali).

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Third, stationarity of energy consumption is of vital importance for various macroeconomic theories. If a unit root in energy consumption is transmitted to the other macroeconomic variables via the correlation between energy consumption and the economic system, then some macroeconomic theories can become dubious [7]. For instance, business cycle theory assumes that output is stationary [8]. Similarly, the law of one price is premised on the assumption that real exchange rates do not contain a unit root [3]. Hence, if the unit root properties of energy consumption can be transferred to the other macroeconomic variables such as output and prices, then doubt may be cast on the validity of some macroeconomic theories.

The fourth reason: stationarity of energy consumption that has become a crucial issue is concerned with modeling the relationship between energy consumption and economic growth [9]. This relationship has been investigated intensively since the beginning of the 1980s.[1] Because the results of these studies have important policy implications, finding the correct modeling approach plays a crucial role in terms of planning appropriate energy and economic growth strategies. For instance, if both energy consumption and economic growth do not contain a unit root, then a vector autoregressive (VAR) model will be the best choice for modeling. On the other hand, if these variables are co-integrated, use of an error-correction model is required [3]. Thus, determining the stationarity properties of energy consumption precisely is a prerequisite for reaching reliable policy formulations.

Finally, whether energy consumption is stationary plays a vital role in forecasting energy consumption. If energy consumption is stationary, future values of energy consumption can be forecasted by using past values. However, if energy consumption has a unit root, it is not possible to forecast future movements of energy consumption on the basis of past behavior [13].

In this study, we investigate the stationarity properties of energy consumption per capita for 109 countries by using a unit root test with a Fourier function over the period 1960–2011. To the best of our knowledge, the methodology we use has never been applied to examine the stationarity of energy consumption before. Hence, we contribute to the existing literature by applying a new econometric methodology to analyze the stationarity of energy consumption. Our econometric methodology is capable of capturing the unknown nature of structural breaks. As is well known, there are a number of crucial economic events that have had powerful effects on energy markets in the past 40 years. Some of these events are the oil crises of the 1970s, the 1985 crash in oil prices, and Iraq's invasion of Kuwait in 1990 [13]. Since structural changes in energy markets critically affect the results of unit root tests, taking these changes into account is a very significant factor in reaching reliable findings [14]. Thus, our main contribution to the existing literature is providing reliable and robust results by considering the unknown nature of structural breaks in energy consumption series.

The rest of this paper is set out as follows. In Section 2, we present a brief review of selected studies on the unit root tests for energy consumption. In Section 3, we describe the econometric methodology. In Section 4, we discuss data and empirical results, and in the final section, we summarize the conclusions and briefly explain the emerging policy implications.

2. A brief literature review

The first study that specifically examines the unit root properties of energy consumption is Narayan and Smyth's [7]. In this study, Narayan and Smyth apply the conventional Augmented Dickey–Fuller (ADF) unit root test to annual data for 182 countries over the period 1979–2000. According to the ADF test results, energy consumption is stationary for only 31% of countries at the 10% level. To make a comparison, Narayan and Smyth also use the t-bar test developed by Im, Peseran, and Shin [15]. Using this test, they find overwhelming evidence that energy consumption does not contain a unit root. Since this study, there has been a surge in empirical studies that investigate the stationarity of energy consumption.[2] Another study that uses the ADF unit root test is Hasanov and Telatar's [3]. In this study, the ADF unit root test is applied for 178 countries using annual data over the period 1980–2006. As in Narayan and Smyth's study, the unit root null hypothesis can be rejected for only 31% of countries. However, Hasanov and Telatar apply the test procedures of also Kapetanios, Shin, and Snell [16] and Sollis [17] to take into account nonlinearities and structural breaks. Using these tests, they find that most of the series are stationary.

Because conventional univariate unit root tests without structural breaks have low power to reject the unit root null hypothesis [18], a second strand of literature that has used univariate unit root tests with structural breaks has emerged [1,14,19–23]. According to the results of these studies, it is usually found that energy consumption is stationary when structural breaks are taken into account.

Besides structural breaks, conventional unit root tests have low power to reject the unit root null hypothesis in the presence of nonlinearities and fractional integration [24]. To eliminate this problem, some studies have used nonlinear and fractional unit root tests to investigate whether energy consumption is stationary [1,3,25–30]. Studies that apply nonlinear unit root tests usually find evidence that supports nonstationarity of energy consumption [1,3,25]. Alternatively, the results of studies that use fractional unit root tests depend on energy type and sector [26–30]. For instance, Lean and Smyth [26] apply univariate and multivariate Lagrange Multiplier tests for fractional integration of monthly data on disaggregated petroleum consumption in the United States over the period January 1973–July 2008. According to the univariate test results, energy consumption is stationary for more than 50% of the 24 series. However, when multivariate tests are used, it is found that petroleum consumption in the commercial and industrial sector is fractionally integrated, while petroleum consumption in the residential sector is stationary.

Finally, some researchers have employed panel unit root tests with and without structural breaks to increase the number of observations and thus the power of the tests [4,6,7,13,20,24,31–33]. These studies can be classified into three groups. In the first group of studies, structural breaks are not taken into account [4,7,33], while in the second group, panel unit root tests with structural breaks are applied [13,24,31]. The last group of studies uses both the panel unit root tests with and without structural breaks [6–20,32]. The results of these studies are mixed. However, the studies that employ panel unit root tests with structural breaks usually find evidence in favor of stationarity.

3. Econometric methodology

This study employs the Fourier Lagrange Multiplier (FLM) unit root test of Enders and Lee [34], which is a variant of the Flexible Fourier transform (i.e., Gallant [35]) and is capable of capturing the unknown nature of structural breaks without information about the locations or numbers of breaks.

The FLM unit root test is based on the Lagrange Multiplier (LM) principle, which is more powerful than the Dickey–Fuller approach, since LM-type unit root tests allow the same set of

[1] See Ozturk [10], Payne [11], and Payne [12] for a literature survey of this issue.

[2] For a detailed survey of the literature see Symth [9].

nuisance parameters under both null and alternative hypotheses (Pfaff [36]). We consider the following data-generating process by following the study of Enders and Lee [34]:

$$y_t = \alpha_0 + \gamma t + \alpha_k \sin\left(\frac{2\pi kt}{T}\right) + \beta_k \cos\left(\frac{2\pi kt}{T}\right) + e_t, \quad k \le T/2$$
$$e_t = \rho e_{t-1} + \varepsilon_t \tag{1}$$

While $\rho = 1$ under the null hypothesis of a unit root, $\rho < 1$ under the alternative hypothesis of stationarity. The procedure of Enders and Lee [34] is based on the LM methodology of Schmidt and Phillips [37] and Amsler and Lee [38] by imposing the null restriction and estimating the following regression using first differences:

$$\Delta y_t = \delta_0 + \delta_1 \Delta \sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \Delta \cos\left(\frac{2\pi kt}{T}\right) + u_t \tag{2}$$

The estimated coefficients, $\tilde{\delta}_0$, $\tilde{\delta}_1$, and $\tilde{\delta}_2$ are employed to construct the detrended series as follows:

$$\tilde{S}_t = y_t - \tilde{\psi} - \tilde{\delta}_0 t - \tilde{\delta}_1 \sin\left(\frac{2\pi kt}{T}\right) - \tilde{\delta}_2 \cos\left(\frac{2\pi kt}{T}\right), \quad t = 2, \ldots, T \tag{3}$$

where $\tilde{\psi} = y_1 - \tilde{\delta}_0 - \tilde{\delta}_1 \sin(2\pi kt/T) - \tilde{\delta}_2 \cos(2\pi kt/T)$.[3] The detrended series is employed in testing regression, which has the following expression:

$$\Delta y_t = \phi \tilde{S}_{t-1} + d_0 + d_1 \Delta \sin(2\pi kt/T) + d_2 \Delta \cos(2\pi kt/T) + \varepsilon_t \tag{4}$$

The LM test statistic (τ_{LM}) is the t-test for the null hypothesis $\phi = 0$, which shows that y_t has a unit root. The innovation process ε_t is assumed to satisfy Phillips and Perron's [39] conditions to allow for serially correlated and also heterogeneously distributed innovations. Eq. (4) can be augmented with lagged values of $\Delta\tilde{S}_{t-1}$ to ensure that there is no remaining serial correlation.

Enders and Lee [34] show that the asymmetric distribution of τ_{LM} depends on only the frequency$k$, but is invariant to the magnitudes of α_k, β_k, α_0, and γ. They suggest determining the value of k using the integer values 1–5 and choosing the k, which minimizes the sum of squared residuals (SSR) from Eq. (4).

If a nonlinear trend is absent, a standard unit root test without a nonlinear trend would be more powerful than the FLM unit root test, so we use the following F-statistic to test the existence of a nonlinear trend:

$$F(k) = \frac{(SSR_0 - SSR_1(k))/2}{SSR_1(k)/(T-q)}$$

where$SSR_1(k)$ shows the sum of squared residuals from Eq. (4), q shows the number of regressors, and SSR_0 is the SSR from Eq. (4) without trigonometric terms. Since the distribution of this statistic is not standard, Enders and Lee [34] tabulated relevant critical values in their paper. If the null of absence of a nonlinear trend is rejected, then FML unit root test will be employed; otherwise the usual unit root tests without a nonlinear trend will be used.

4. Data and empirical results

We use energy consumption per capita (ECPC) data obtained from the World Development Indicators for the period 1960–2011 for 109 countries. We determine the maximum lag length by following the suggestion of Schwert [40] and use the t-sig approach of Campbell and Perron [41] to choose the optimal lag length.

Table 1 reports the results of the FLM unit root test. Due to the lack of data, we apply unit root tests in different date ranges which are presented in the second column of Table 1. Column 3 of Table 1 shows the best frequency, selected using a grid search to find the minimum SSR estimating Eq. (4) for each integer k=1,…,5. The results indicate that a single frequency works best for the most of the series. The $F(k)$ statistics in the fifth column of the table show that trigonometric terms should be included in the estimated models for 89 of 109 countries. Therefore, we apply the FLM unit root tests for only these countries. FLM unit root test statistics in Column 6 indicate that the ECPCs of Algeria, Australia, Benin, Bolivia, Canada, Costa Rica, Denmark, Egypt, Greece, Guatemala, Hong Kong, Ireland, Jordan, Korea Democratic Republic, Mexico, Myanmar, The Netherlands, New Zealand, Oman, Paraguay, Singapore, Tanzania, The United States and Vietnam are stationary.

For the remaining countries, we use standard LM unit root test since standard unit root tests are more powerful than the Fourier unit root tests in the case of insignificant trigonometric terms, as stated by Enders and Lee [34]. So, we present the results of standard LM unit root tests in the last column, which shows that we can reject the null of a unit root for only Qatar.

In the energy literature, it is claimed that there are several reasons that may explain the stationarity of energy consumption. For instance, Hsu, Lee and Lee [4] state that the stationarity of energy consumption results from the following reasons: (1) abundance of energy resources, (2) less energy consumption, (3) introduction of new environmental laws and (4) middle income level. Furthermore, Hasanov and Telatar [3] assert that the energy consumption of relatively developed and high income countries is stationary as well. As is well known, Algeria, Australia, Benin, Bolivia, Canada, Costa Rica, Egypt, Guatemala, Jordan, Mexico, Myanmar, Oman, Paraguay, Tanzania, The United States, Vietnam and Qatar are countries which are located on the resource-rich regions of the world. Since we have found that the energy consumption series pertaining to these countries are stationary, our results support the first argument put forward by Hsu, Lee and Lee. On the other hand, the other energy consumption series that we found stationary belong to Denmark, Greece, Hong Kong, Ireland, Korea Democratic Republic, The Netherlands, New Zealand and Singapore. Because of the fact that these countries are comparatively developed and high income countries, our results comply with the argument of Hasanov and Telatar as well.

5. Conclusion

There has been an increasing interest in investigating the stationarity properties of energy consumption in the past decade for several reasons. Whether energy consumption is stationary is a crucial issue in terms of energy demand management policies and forecasting future values of energy consumption. If energy consumption does not contain a unit root, energy demand management policies that aim to affect energy consumption permanently will not be effective since shocks to energy consumption can have only transitory effects on energy consumption. Also, if energy consumption is stationary, it is possible to forecast future values of energy consumption by using past values. Alternatively, if energy consumption contains a unit root, energy demand management policies will have permanent effects on energy consumption, and it will not be possible to forecast future behavior of energy consumption on the basis of past behavior.

In this study, we examine the stationarity properties of energy consumption per capita for 109 countries by using a unit root test with a Fourier function over the period 1960–2011. The main contribution of our study to the existing literature is that we use a new unit root test that has never been applied to examine the stationarity of energy consumption before which is capable of capturing the unknown nature of structural breaks to energy consumption. Since structural breaks can crucially decrease the

[3] y_1 is the first observation of y_t.

Table 1
The results of unit root tests.

Country	Date interval	SSR	Freq	$F(k)$	FLM	LM
Albania	1971–2010	0.4207	1	27.1254*	−3.4724 (0)	–
Algeria	1971–2010	1.6731	1	8.1913***	−8.0374 (3)*	–
Angola	1971–2010	0.9704	1	38.9714*	−1.5428 (1)	–
Argentina	1971–2010	1.3384	1	32.2832*	−1.6649 (1)	–
Australia	1960–2011	0.0086	1	9.4669**	−17.0901 (8)*	–
Austria	1960–2011	0.0534	1	2.8955	−30.8298 (0)	−1.8476 (7)
Bahrain	1971–2010	6.2568	3	1.3402	−4.1306 (1)	1.2542 (7)
Bangladesh	1971–2010	0.713	1	7.0397	−8.6384 (4)	1.6914 (9)
Belgium	1960–2011	0.0546	1	5.3768	−22.1445 (0)	−1.5056 (0)
Benin	1971–2010	2.2519	1	11.9938*	−6.6174 (2)*	–
Bolivia	1971–2010	2.2734	1	11.0454**	−5.9043 (0)*	–
Brazil	1971–2010	0.4182	1	47.5971*	−1.5083 (1)	–
Brunei Darussalam	1971–2010	0.1052	2	0.4144	0.5180 (9)	−1.8026 (1)
Bulgaria	1971–2010	1.69	3	1.1967	−5.1426 (1)	−1.3174 (5)
Cameroon	1971–2010	0.0001	1	22307.5229*	−0.3672 (9)	–
Canada	1960–2011	0.0087	1	11.8128*	−16.0079 (8)*	–
Chile	1970–2011	0.0724	2	0.8656	−23.3760 (1)	−2.021 (1)
China	1971–2010	0.0303	1	83.0312*	−1.4203 (2)	–
Colombia	1971–2010	0.2073	1	30.6828*	−2.5117 (0)	–
Congo, Dem. Rep.	1971–2010	0.1582	1	25.2355*	−2.5485 (0)	–
Congo, Rep.	1971–2010	0.663	2	2.5963	−7.2492 (3)	−1.6232 (3)
Costa Rica	1971–2010	0.7307	1	14.2018*	−5.8993 (0)*	–
Cote d'Ivoire	1971–2010	0.0015	2	352.8592*	−0.1649 (2)	–
Cuba	1971–2010	0.0843	1	48.0103*	−1.4652 (0)	–
Cyprus	1971–2010	0.0226	1	67.6653*	−0.4305 (2)	–
Czech Republic	1970–2011	0.0084	1	24.7145*	−1.0371 (2)	–
Denmark	1960–2011	0.0662	1	12.082*	−12.2536 (0)*	–
Dominican Republic	1971–2010	0.0008	1	271.8796*	−3.6942 (9)	–
Ecuador	1971–2010	0.0001	2	1277.7407*	0.4294 (8)	–
Egypt, Arab Rep.	1960–2011	1.2828	1	7.5581***	−6.9738 (0)*	–
El Salvador	1960–2011	0.0036	1	60.4286*	−0.6909 (9)	–
Ethiopia	1971–2010	0.2862	1	30.8934*	−1.3986 (4)	–
Finland	1960–2011	0.0408	1	6.9985	−14.4088 (8)	−0.63 (7)
France	1960–2011	0.0451	1	3.0697	−28.8503 (0)	−1.4492 (6)
Gabon	1971–2010	1.3401	2	2.8819	−11.7127 (3)	−2.013 (5)
Germany	1960–2011	0.0768	1	5.0232	−13.4706 (2)	−1.38 (6)
Ghana	1971–2010	0.0398	1	66.2873*	−0.3930 (8)	–
Greece	1960–2011	0.0401	3	4.1911**	−73.1106 (9)*	–
Guatemala	1971–2010	1.0387	1	19.7392*	−4.9086 (0)*	–
Haiti	1971–2010	0.2609	1	38.2446*	−1.3403 (1)	–
Honduras	1971–2010	0.1413	1	39.7499*	−1.1718 (3)	–
Hong Kong SAR, China	1971–2010	1.1581	1	15.4899*	−4.0929 (0)***	–
Hungary	1965–2011	0.0009	2	970.4176*	0.0182 (2)	–
Iceland	1960–2011	0.0677	1	6.0516	−23.6865 (7)	−1.38 (6)
India	1971–2010	0.3876	1	8.1397***	−3.5407 (5)	–
Indonesia	1971–2010	0.7514	3	1.9458	−12.3472 (0)	−0.9838 (8)
Iran, Islamic Rep.	1971–2010	0.0429	1	19.5747*	−2.4544 (9)	–
Iraq	1971–2010	0.0337	4	4.3375**	−1.7675 (7)	–
Ireland	1960–2011	0.0481	1	8.4895**	−25.9343 (0)*	–
Israel	1970–2011	0.0432	4	2.4709	−10.9704 (8)	−2.4637 (7)
Italy	1960–2011	0.0306	1	13.1038*	−50.7051 (0)*	–
Jamaica	1971–2010	0.2693	1	16.5118*	−2.7358 (0)	–
Japan	1960–2011	0.026	1	2.9036	−18.3072 (9)	−0.1724 (7)
Jordan	1971–2010	3.538	1	7.3412***	−8.8974 (0)*	–
Kenya	1971–2010	0.8518	2	2.3624	−10.7738 (0)	−1.8761 (9)
Korea, Dem. Rep.	1971–2010	0.4335	1	20.2286*	−4.7027 (0)*	–
Korea, Rep.	1970–2011	0.0654	2	2.3682	−81.4029 (0)	−1.8481 (2)
Kuwait	1971–2010	0.7238	1	18.7411*	−2.3334 (1)	–
Lebanon	1971–2010	0.6381	3	1.0289	−4.8786 (6)	−2.1518 (0)
Libya	1971–2010	0.1492	1	80.2006*	−1.1619 (2)	–
Luxembourg	1960–2011	0.0532	1	13.3165*	−3.4587 (2)	–
Malaysia	1971–2010	0.0198	1	149.0352*	−0.2613 (2)	–
Malta	1971–2010	0.7806	1	26.0149*	−2.7849 (1)	–
Mexico	1970–2011	0.024	1	8.1802***	−17.4937 (2)*	–
Morocco	1971–2010	0.1412	1	5.8544	−3.9420 (5)	−1.896 (8)
Mozambique	1971–2010	0.0381	1	15.3876*	−1.1924 (2)	–
Myanmar	1971–2010	0.1147	1	11.4016**	−7.9592 (3)*	–
Nepal	1971–2010	1.3361	1	5.2104	−10.1038 (2)	−1.7643 (9)
Netherlands	1960–2011	0.0379	1	9.386**	−11.1567 (9)*	–
New Zealand	1960–2011	0.0277	4	4.0976**	−48.0648 (5)*	–
Nicaragua	1971–2010	0.0001	1	813.3744*	−0.0761 (9)	–
Nigeria	1971–2010	0.1521	1	35.4939*	−0.8804 (2)	–
Norway	1960–2011	0.0379	3	1.4355	−42.3924 (8)	–
Oman	1971–2010	1.96	1	10.3571**	−5.8376 (0)*	–
Pakistan	1971–2010	0.3285	2	2.4887	−9.1551 (4)	−1.6975 (0)

Table 1 (*continued*)

Country	Date interval	SSR	Freq	$F(k)$	FLM	LM
Panama	1971–2010	0.2107	2	0.9455	−12.5025 (5)	−1.6109 (5)
Paraguay	1971–2010	4.664	1	15.3612*	−5.6005 (0)*	–
Peru	1971–2010	0.555	1	34.2527*	−1.0834 (1)	–
Philippines	1971–2010	6.1952	3	0.2478	−5.6257 (4)	−2.22 (3)
Poland	1960–2011	0.0579	1	5.3536	−9.7489 (0)	–
Portugal	1960–2011	0.0896	2	2.0737	−72.2501 (0)	–
Qatar	1971–2010	6.4048	2	3.3865	−8.6844 (3)	−4.2857 (7)*
Romania	1971–2010	1.1706	1	30.7873*	−1.4502 (0)	–
Saudi Arabia	1971–2010	1.0801	1	23.0347*	−1.6515 (0)	–
Senegal	1971–2010	0.1616	1	31.1153*	−0.4201 (2)	–
Singapore	1971–2010	1.2979	1	19.9629*	−4.1064 (0)**	–
Slovak Republic	1970–2011	0.0001	1	437.2182*	1.2019 (2)	–
South Africa	1971–2010	0.2919	1	27.8575*	−1.0745 (1)	–
Spain	1960–2011	0.0284	4	1.4381	−68.631 (9)	–
Sri Lanka	1971–2010	0.0873	1	28.0648*	−1.5351 (1)	–
Sudan	1971–2010	0.4275	1	15.596*	−3.5171 (4)	–
Sweden	1960–2011	0.0423	3	0.0407	−21.9178 (9)	–
Switzerland	1960–2011	0.0299	3	1.0004	−38.8842 (7)	–
Syrian Arab Republic	1971–2010	0.0141	1	130.5203*	−1.9975 (9)	–
Tanzania	1971–2010	3.0288	1	14.0531*	−4.8105 (3)*	–
Thailand	1971–2010	0.3965	1	0.3966	−1.0886 (3)	−1.6312 (1)
Togo	1971–2010	5.3814	2	3.1981	−7.7253 (4)	−1.6267 (9)
Trinidad and Tobago	1971–2010	0.2006	1	54.8632*	−0.3168 (4)	–
Tunisia	1971–2010	4.0939	4	0.102	−4.8918 (4)	−1.4767 (7)
Turkey	1960–2011	0.0722	3	1.3185	−66.2452 (0)	–
United Arab Emirates	1971–2010	0.8415	1	41.4594*	−1.3935 (3)	–
United Kingdom	1960–2011	0.0001	1	7123.8764*	3.1743 (2)	–
United States	1960–2011	0.0082	1	18.4085*	−13.4385 (3)*	–
Uruguay	1971–2010	0.8056	1	21.9782*	−2.2971 (0)	–
Venezuela, RB	1971–2010	1.5179	3	0.8009	−3.4710 (1)	−1.5738 (4)
Vietnam	1971–2010	0.4124	1	13.4282*	−4.8670 (0)*	–
Yemen, Rep.	1971–2010	1.0329	3	0.8087	−11.5626 (6)	−1.4339 (2)
Zambia	1971–2010	1.3661	1	12.6537*	−1.9656 (1)	–
Zimbabwe	1971–2010	0.0664	1	24.8924*	−1.3769 (4)	–

Note: Numbers in the parentheses show the optimal lag length.

* Significance at the 1% level.

** Significance at the 5% level.

*** Significance at the 10% level.

power of unit root tests, we provide more reliable and robust evidence than those of the other studies that ignore this issue of considering the structural breaks in the series.

According to our test results, energy consumption per capita is stationary in Algeria, Australia, Benin, Bolivia, Canada, Costa Rica, Denmark, Egypt, Greece, Guatemala, Hong Kong, Ireland, Jordan, Korea Democratic Republic, Mexico, Myanmar, The Netherlands, New Zealand, Oman, Paraguay, Qatar, Singapore, Tanzania, The United States and Vietnam. This means that it is possible to forecast the future values of energy consumption in these countries by using past values. In addition to this, energy demand management policies can have only transitory effects on energy consumption in these countries. So, policy makers should consider this fact and avoid designing policies that aim to make long-term changes on energy consumption.

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